

A Surface Acoustic Wave Mercury Vapor Sensor

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Abstract

Mercury originating from nuclear fuel and weapons production and disposal, fossil fuel combustion and industrial processes is a major environmental pollutant that exists in air, soil and groundwater. Mercury is particularly dangerous since it can bio-accumulate within the food chain and lead to irreversible neurological disorders and other health related problems. Current laboratory techniques that are used to detect mercury require a variety of elaborate separation strategies in conjunction with chromatographic, electrochemical or spectroscopic methods. Although these techniques are sensitive, they are not appropriate for *in situ* monitoring and typically, samples must be collected and shipped to a central processing facility for analysis.

A sensor for the *in situ* detection and measurement of low concentrations of gaseous mercury in air is presented. The sensor is based upon a SAW delay line oscillator with a gold-coated delay path. Gaseous mercury interacts rigorously with this gold film, forming an amalgam. The resulting changes in film mechanical properties (i.e. mass, viscosity, elasticity) are manifested as fluctuations in oscillation frequency. Measurement of gas concentration is achieved by operating the sensing element at a temperature where gas-film reaction kinetics result in equilibrium rates of mercury amalgamation and desorption. This equilibrium value of amalgamated mercury is highly dependent upon the gas concentration. Thus, the delay line oscillation frequency is ultimately a sensitive measure of gaseous mercury concentration.

Responses of this sensor to gaseous mercury concentrations in the ppb range are presented. The sensor response features are analyzed in terms of response time, recovery time, minimum detection limit, saturation detection limit and linearity. The relationship between the sensor response and operating temperature is investigated, as well. Conclusions are drawn and future improvements to the sensor are suggested.